

## REMARKS

The Office's withdrawal of all prior objections to Claims 1-6 and 16-21, all associated correction requirements, and all prior rejections of Claims 1-6 and 16-21, is acknowledged and much appreciated.

Claim 22 has been amended merely to place an inadvertently omitted hyphen in the word "anti-reflection." Claims 33, 34, and 36 have been reworded merely for clarification purposes. Claim 39 has been amended merely to remove an inadvertently used indefinite article "a" with the definite article "the," in view of the antecedent present in the preamble. Each of the foregoing claim amendments adds no new matter.

Claims 32-34, 36 and 39-52 have been objected to because of alleged informalities. No rule or statutory basis has been articulated as a basis for any of these objections. As to Claim 32, the objection is directed to terms that do not actually appear in Claim 32. It is believed that the objection is in error. As to each of Claims 33, 34, and 36, it is believed the objection thereto is moot in view of the amendments to the subject claim. As to Claims 39-52, it is believed the objection thereto is moot in view of the amendment to Claim 39. As to Claim 49, it is respectfully submitted that the objection is in error. It is quite clear that the method of Claim 49 comprises the depositing recitations of Claim 39, from which it depends, and thereafter, the heating of the substrate, as fully and clearly recited in Claim 49. Nothing further is required, and the Office has not demonstrated otherwise. It is believed that each of above-mentioned rejections is either moot or has been overcome.

Claims 22-43 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over U.S. Patent No. 5,344,718 to Hartig *et al.* (hereinafter, simply "Hartig") in view of U.S. Patent No. 6,115,180 to Hirai *et al.* (hereinafter, simply "Hirai"). These rejections are respectfully traversed.

It is generally known that in an optical coating or the making of an optical coating such as that of Hartig, the diffusion of an undesirable substance, such as oxygen, into the silver layer is undesirable and to be avoided. Hartig thus employs nickel or nickel alloy barrier layers that surround the silver layer, as recognized by the Office. It is generally known that such barrier layers should be substantially free of oxide. See U.S. Patent No. 6,514,620 to Lingle *et al.*, col.16, ll.17-33, for example. Hartig also employs outer Si<sub>3</sub>N<sub>4</sub> dielectric layers that are deposited in an oxygen-free environment, such that oxide formation is avoided.

Hirai teaches an amorphous  $\text{SiO}_2\text{-TiO}_2$  structure, which is an oxide. It is submitted that one of ordinary skill in the art would not have been motivated to replace Hartig's  $\text{Si}_3\text{N}_4$  dielectric layers that are deposited in an oxygen-free environment with Hirai's oxygen-containing, amorphous  $\text{SiO}_2\text{-TiO}_2$  structure, as this would have introduced oxygen into the optical coating, which would have been counter to the teaching of Hartig and counter to the general knowledge regarding undesirable oxygen presence. Indeed, one so skilled would have been motivated not to make such a substitution, in view of Hartig and the general knowledge just described.

Additionally, one so skilled would have been motivated not to make such a substitution, in view of the general knowledge concerning amorphous structures. In this regard, it has long been generally known that the diffusion coefficient associated with a random non-crystalline structure, or an amorphous structure, is greater by several orders of magnitude than that associated with a crystalline structure. See Kingery, *Introduction to Ceramics*, 4<sup>th</sup> Printing, pp. 240-241 (1967), a copy of which is enclosed. This means that in the case of an amorphous material that contains an undesirable substance, such as oxygen, it would have been expected that the undesirable substance would be quite able to diffuse through the amorphous structure.

In view of the foregoing general knowledge concerning amorphous structures, one of ordinary skill in the art, at the relevant time, would have considered Hirai's oxygen-containing, amorphous  $\text{SiO}_2\text{-TiO}_2$  oxide structure to be a medium through which the oxygen could readily diffuse. One so skilled would not have been motivated to replace Hartig's  $\text{Si}_3\text{N}_4$  dielectric layers that are deposited in an oxygen-free environment with Hirai's amorphous  $\text{SiO}_2\text{-TiO}_2$  oxide structure, as it would have been expected that the amorphous structure would allow undesirable oxygen to diffuse with relative ease to the barrier layer. As remarked upon above, it is generally known that such barrier layers should be substantially free of oxygen, such that further diffusion of oxygen into the silver is avoided.

It is respectfully submitted that the Office has failed to show a motivation for the combination of Hartig in view of Hirai as suggested by the Office. Further, even if one of ordinary skill in the art would have somehow been motivated to combine Hartig in view of Hirai as suggested by the Office, *arguendo*, one so skilled would have had no reasonable

expectation of success, given the negative teachings described above. The Office has not shown otherwise.

It is noted that the Office has made certain remarks in reference to Claims 28-32. See Final Office Action, p.4-5. The Office appears to be taking the position that it is implicit that the amorphous structure of the multi-layered structure that would allegedly result from the alleged combination of Hartig and Hirai, *arguendo*, would maintain various of its characteristics if heated to a heat-treatment temperature. This position is asserted without support. As it appears that the Office may be taking official notice of this position, any such official notice is traversed. It is pointed out that circumstances in which official notice is relied upon in a final rejection, as here, should be rare. See MPEP 2144.03. The only reference the Office has provided that describes what happens when an amorphous film is heat-treated is Hsu *et al.*, *Single- and dual-ion-beam sputter deposition of titanium oxide films*, Applied Optics, Vol. 37, No. 7, pp. 1171-1176. That reference evidences a change in various characteristics, such as refractive index, of an amorphous titanium oxide film when heat-treated. This evidence is contrary to the position of the Office, such that the Office's position is traversed, and the Office is asked to produce authority in support of any official notice of this position. MPEP 2144.03. It is further pointed out that the subject matter of Claims 28-32 is not product-by-process, as is clear from the preamble of those claims. The Office's assertions to the contrary are respectfully traversed.

In view of the foregoing, it is respectfully submitted that the Office has failed to make a *prima facie* showing in support of the rejections of Claims 22-43 over the alleged combination of Hartig in view of Hirai.

Claims 39 and 49-52 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over U.S. Patent No. 6,514,620 to Lingle *et al.* (hereinafter, simply "Lingle") in view of Hirai. These rejections are respectfully traversed.

It is generally known that in an optical coating or the making of an optical coating such as that of Lingle, the diffusion of an undesirable substance, such as oxygen, into the silver layer is undesirable and to be avoided. Lingle thus employs nickel or nickel alloy barrier layers that surround the silver layer. Lingle teaches that such barrier layers are substantially free of oxygen. See Lingle, col.16, ll.17-33, for example. Lingle also employs

outer  $\text{Si}_3\text{N}_4$  dielectric layers that are deposited in an oxygen-free environment, such that oxide formation is avoided. See Lingle, col.12, ll.51-53, for example.

Hirai teaches an amorphous  $\text{SiO}_2\text{--TiO}_2$  structure, which is an oxide. It is submitted that one of ordinary skill in the art would not have been motivated to replace Lingle's  $\text{Si}_3\text{N}_4$  dielectric layers that are deposited in an oxygen-free environment with Hirai's oxygen-containing, amorphous  $\text{SiO}_2\text{--TiO}_2$  oxide structure, as this would have introduced oxygen into the optical coating, which would have been counter to the teaching of Lingle and counter to the general knowledge regarding undesirable oxygen presence. Indeed, one so skilled would have been motivated not to make such a substitution, in view of Lingle and the general knowledge just described.

Additionally, one so skilled would have been motivated not to make such a substitution, in view of the general knowledge concerning the diffusion characteristics of amorphous structures, as remarked upon previously herein. In brief recap, in the case of an amorphous material that contains an undesirable substance, such as oxygen, it would have been expected that the undesirable substance would be quite able to diffuse through the amorphous structure.

In view of the foregoing general knowledge concerning amorphous structures, one of ordinary skill in the art, at the time of the invention, would have considered Hirai's oxygen-containing, amorphous  $\text{SiO}_2\text{--TiO}_2$  oxide structure to be a medium through which the oxygen could readily diffuse. One so skilled would not have been motivated to replace Lingle's  $\text{Si}_3\text{N}_4$  dielectric layers that are deposited in an oxygen-free environment with Hirai's amorphous  $\text{SiO}_2\text{--TiO}_2$  oxide structure, as it would have been expected that the amorphous structure would allow undesirable oxygen to diffuse with relative ease to the barrier layer. As remarked upon above, Lingle teaches that such barrier layers should be substantially free of oxygen, such that further diffusion of oxygen into the silver is avoided.

It is respectfully submitted that the Office has failed to show a motivation for the combination of Lingle in view of Hirai as suggested by the Office. Further, even if one of ordinary skill in the art would have somehow been motivated to combine Lingle in view of Hirai as suggested by the Office, *arguendo*, one so skilled would have had no reasonable expectation of success, given the negative teachings described above. The Office has not shown otherwise.

In view of the foregoing, it is respectfully submitted that the Office has failed to make a *prima facie* showing in support of the rejections of Claims 39 and 49-52 over the alleged combination of Lingle in view of Hirai.

Claims 44-48 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over Lingle in view of Hirai, as applied to Claim 39 (see above), and further in view of Hsu *et al.*, *Single- and dual-ion-beam sputter deposition of titanium oxide films*, Applied Optics, Vol. 37, No. 7, pp. 1171-1176 (hereinafter, simply "Hsu"). These rejections are respectfully traversed.

The remarks above concerning the underlying alleged combination of Lingle in view of Hirai, as applied to Claim 39 (above), are incorporated herein by reference. As the underlying alleged combination of Lingle in view of Hirai is insufficient as to Claim 39 (*inter alia*), for the reasons remarked upon above, it is believed that these rejections cannot stand.

Further, just as one of ordinary skill in the art would not have been motivated to replace Lingle's  $\text{Si}_3\text{N}_4$  dielectric layers that are deposited in an oxygen-free environment with Hirai's oxygen-containing, amorphous  $\text{SiO}_2\text{-TiO}_2$  oxide structure, as this would have introduced oxygen into the optical coating and would have been expected to allow that oxygen to diffuse readily into the barrier layer, one so skilled would similarly not have been motivated to deposit Hirai's amorphous  $\text{SiO}_2\text{-TiO}_2$  oxide structure in the manner (deposition at a particular temperature and a particular rate) of Hsu.

As to temperature, Hsu teaches that titanium oxide films deposited at room temperature are amorphous, as recognized by the Office. As set forth above, based on general knowledge regarding the undesirability of oxygen in an optical coating such as that of Lingle and the diffusion properties associated with an amorphous structure such as the amorphous oxide structure of Hirai, use of an amorphous structure such as Hirai's in a structure such as Lingle's would have been undesirable. Thus, Hsu's depositing of a film such as Hirai's at room temperature, such that the film would be amorphous, would have been counter to the teaching of Lingle and counter to the general knowledge regarding the undesirability of oxygen and the undesirability of an amorphous source of oxygen in an optical coating such as that of Lingle.

As to deposition rate, the Office asserts a "common [range] of deposition rate, (normally 1 angstrom[] to 20 angstroms per second)," without providing any evidence in

support of such an assertion.—As it appears that the Office may be taking official notice of this assertion, any such official notice is traversed. It is pointed out that circumstances in which official notice is relied upon in a final rejection, as here, should be rare. See MPEP 2144.03. The only reference the Office has provided that sets forth the deposition rate for its amorphous titanium oxide film is Hsu. That deposition rate, at its highest, is 0.035 nm/sec. Hsu: pp. 1172-1173; and Figs. 2 and 7. This deposition rate for an amorphous film is much lower than that asserted by the Office as being common, such that the Office's assertion is traversed, and the Office is asked to produce authority in support of any official notice of this assertion. MPEP 2144.03. Even if the Office's assertion of a common deposition rate for an amorphous titanium oxide film of normally 1 angstrom to 20 angstroms per second were permissible and correct, *arguendo*, this assertion would only show that Hsu teaches a low deposition rate.

It is respectfully submitted that the Office has failed to show a motivation for the combination of Lingle in view of Hirai, as applied to Claim 39 (see above), and further in view of Hsu, as suggested by the Office. Further, even if one of ordinary skill in the art would have somehow been motivated to combine Lingle in view of Hirai, as applied to Claim 39 (see above), and further in view of Hsu, as suggested by the Office, *arguendo*, one so skilled would have had no reasonable expectation of success, given the negative teachings described above. The Office has not shown otherwise.

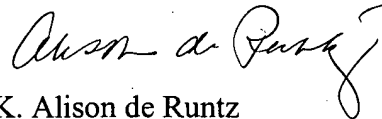
In view of the foregoing, it is respectfully submitted that the Office has failed to make a *prima facie* showing in support of the rejections of Claims 44-48 over the alleged combination of Lingle in view of Hirai, as applied to Claim 39 (see above), and further in view of Hsu.

New Claims 53-56 recite further subject matter that is regarded as the invention. No new matter has been added by virtue of these new claims. It is submitted that Claims 53-56 are patentable in view of the alleged combinations of Hartig in view of Hirai, Lingle in view of Hirai, and Lingle in view of Hirai and further in view of Hsu.

**CONCLUSION**

Claims 22-56 define novel and non-obvious subject matter of the present invention.  
An early notification that the application is in condition for allowance is earnestly solicited.

Respectfully submitted,



K. Alison de Runtz  
Reg. No. 37,119

PARSONS HSUE & DE RUNTZ LLP  
655 Montgomery Street, Suite 1800  
San Francisco, CA 94111  
(415) 318-1160  
(415) 693-0194 (Fax)

ADVANCED TECHNOLOGY OF MATERIALS

*B. Chalmers, R. L. Sproull, A. V. Tobolsky*

PROPERTIES OF METALS AND ALLOYS

*D. Anderson and Kenneth K. Kelley*

1075

5

# Introduction to Ceramics

by

**W. D. Kingery**

ASSOCIATE PROFESSOR OF CERAMICS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

1967

EDITION

**John Wiley & Sons, Inc.,** New York • London • Sydney

**Best Available Copy**

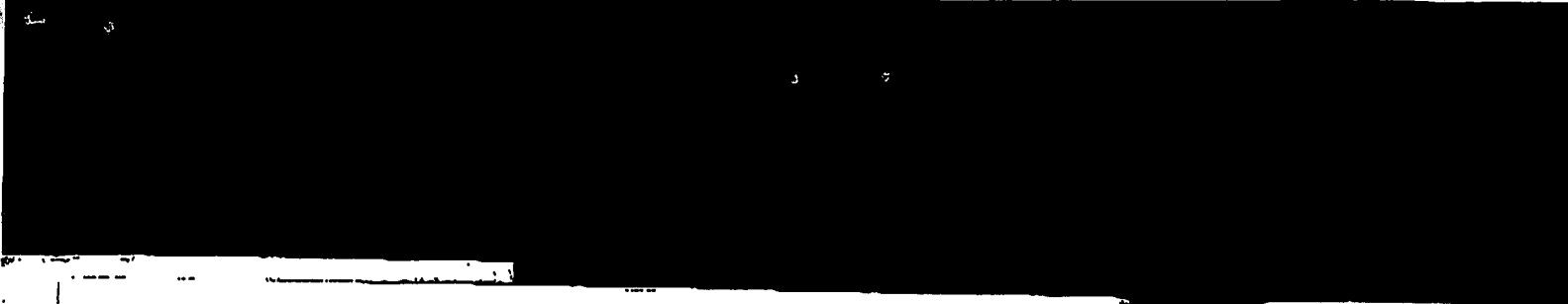
P. 2

NO. 573

VACUUM COATING TECHNOLOGIES

APR. 12. 2005 5:04AM





of  
pro  
tex  
side  
ized  
eral  
rati  
ena  
dur  
tra  
rec  
cer  
tive  
and  
  
bo  
fiel  
the  
cer  
app  
pro  
Sci  
of  
vis  
  
Th  
an  
  
bo  
tec  
ma  
all  
is  
stu  
nee  
wh  
the  
uni  
pro  
vie

---

FOURTH PRINTING, APRIL, 1967

Copyright © 1960 by John Wiley & Sons, Inc.

All Rights Reserved

This book or any part thereof must  
not be reproduced in any form without  
the written permission of the publisher.

Library of Congress Catalog Card Number: 60-53448

Printed in the United States of America

The need for a book such  
my experience in teaching a  
this need has been strength  
and research scientists and  
of the book can for the most  
are better considered as a  
special industry. This cont  
of the new ceramic product  
veloped through the efforts  
ceramic industry.

The present book does :  
However, it is clear that th  
rials and ceramic processes  
Although it would be a grea  
considered ceramic processe  
point of view, engineers en  
to do without the principles  
familiarity with current ei  
cently this was made clear  
it expedient to enter new p.  
ceramics, and optical ceran

Scientists and engineers :  
compartments into which k  
tween them are artificial a  
example, separate discussion  
ash, porcelain enamels, cer

Best Available Copy

value is larger than would have been expected and suggests that the oxygen ion moves as part of an uncharged unit which would contribute to the observed diffusion but not to the electrical conductivity.)

**Silicate glasses.** When a silicate liquid is cooled to form a glass, the network structure of the glassy material becomes rigid in the transition range, but there remain holes in the lattice which are sites for alkali and alkaline earth ions. Under these conditions the mobility of the silicon ions is extremely limited, and all the measured electrical conductivity can be quantitatively ascribed to the mobility of alkali ions. In addition, direct measurements of diffusion coefficients for sodium ions in a sodium silicate glass indicate that diffusion takes place readily. In the glassy structure the entropy for diffusion is negative (calculated from Eq. 8.20); this indicates that on the average the sodium ions tend to rattle about in the hole where they are located so that a more ordered structure occurs at the activated complex position intermediate between the low-energy sites. The experimental activation energy increases while the transition range is being passed through and the silicate structure is gradually relaxing. At temperatures above the transition range the temperature dependence, activation energy, and entropy become similar to those for other liquids, and this region above the transition range can be regarded as a region of a supercooled liquid rather than as a noncrystalline solid. Data for the diffusion of sodium ion in a sodium-silicate glass are reproduced in Fig. 8.12.

These holes in the glassy structure also allow the ready diffusion of small atoms such as helium and hydrogen. An interesting result for the diffusion of these ions has been observed in connection with tensile deformation. When some glasses are tested for diffusion properties under a tensile stress such that the lattice is expanded, it is observed that there is an increased diffusion coefficient once the strain has exceeded about  $2 \times 10^{-4}$ . This suggests that some of the holes already present in the glass open to become microfissures where the glass is under a tensile strain and that they reversibly heal again when the stress is removed. Shear and compressive stresses do not have the same effect on holes. In the same way that hydrogen has a high diffusivity through glass structures, being soluble to a considerable extent, water vapor also is soluble in silicate glasses and has a high diffusion coefficient.

Diffusion characteristics in ionic melts and glasses are particularly important in ceramic technology because in general the diffusion coefficient in the random noncrystalline structure is larger by several orders of magnitude than it is for a crystalline solid. Consequently,

## ATOM MOBILITY

241

diffusion phenomena in a mixture of crystals and glassy material tend to take place predominantly in the glassy phase. This means that the presence of a small amount of glassy material in a ceramic, has a strong influence on the over-all diffusion-controlled processes in a multiphase system. For many ceramic systems, then, the diffusion characteristics in the silicate glass are of the greatest practical importance.

## 3.6 Boundary and Surface Diffusion

Just as diffusion in a noncrystalline glass with a random structure or in a liquid phase is more rapid than diffusion in a crystalline solid, we expect diffusion along grain boundaries in which there is disorder to be more rapid than diffusion through the crystalline lattice. In a similar way, atoms on the surface of a solid are expected to be more mobile than atoms on lattice sites within the crystal volume.

The thorium-tungsten system has been investigated in some detail since the thermionic emission of a tungsten filament is particularly sensitive to the concentration of absorbed ions and can be used as a measure of small surface concentrations. Surface diffusion of thorium on tungsten surfaces, in tungsten samples of different grain size, and through the volume of the material have been measured with resulting diffusivities for these three processes as shown in Table 3.3. It is evident from the values obtained that diffusion is easier along surfaces. It is next easiest along grain boundaries and most difficult through the volume. Similar results have been observed for the self-diffusion of silver through a volume and along grain boundaries. There have been no similar measurements carried out for nonmetal crystals and grain boundaries.

If we assume a model in which there are thick, slowly conducting slabs separated by thin boundary layers of uniform width  $\delta$ , with material entering from a plane surface normal to the planes of the boundaries, this material will diffuse rapidly in along the boundary layers and is lost in part by lateral diffusion into the large grains [J. O.

Table 3.3. Diffusion of Thorium in Tungsten <sup>a</sup>

Surface:	$D_s = 0.47 \exp (-66,400/RT)$
Grain boundary:	$D_b = 0.74 \exp (-90,000/RT)$
Crystal lattice:	$D_l = 1.0 \exp (-120,000/RT)$

<sup>a</sup> From I. Langmuir, *J. Franklin Inst.*, 217, 543 (1934).